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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/897,839	07/21/97	NISHIMOTO	Y

MM42/0617

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EXAMINER	
EATON, K	
ART UNIT	**PAPER NUMBER**
2814	8

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Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary	Application No. 08/897,839	Applicant(s) Nishimoto et al.
	Examiner Kurt Eaton	Group Art Unit 2823

☒ Responsive to communication(s) filed on *Mar 29, 1999*.

☒ This action is **FINAL.**

☐ Since this application is in condition for allowance except for formal matters, **prosecution as to the merits is closed** in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire *3* month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claims

☒ Claim(s) *2-4, 6, 8-14, 16, 17, and 19-32* is/are pending in the application.

Of the above, claim(s) _____ is/are withdrawn from consideration.

☐ Claim(s) _____ is/are allowed.

☒ Claim(s) *2-4, 6, 8-14, 16, 17, and 19-32* is/are rejected.

☐ Claim(s) _____ is/are objected to.

☐ Claims _____ are subject to restriction or election requirement.

Application Papers

☒ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

☐ The proposed drawing correction, filed on _____ is ☐approved ☐disapproved.

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☒ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☒ All ☐ Some* ☐ None of the CERTIFIED copies of the priority documents have been

☒ received.

☐ received in Application No. (Series Code/Serial Number) _____.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: _____.

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

☐ Notice of References Cited, PTO-892

☐ Information Disclosure Statement(s), PTO-1449, Paper No(s). _____

☐ Interview Summary, PTO-413

☒ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

--- SEE OFFICE ACTION ON THE FOLLOWING PAGES ---

DETAILED ACTION

Priority

1. Receipt is acknowledged of papers submitted under 35 U.S.C. 119(a)-(d), which papers have been placed of record in the file.

Claim Rejections - 35 USC § 103

2. Claims 1, 5, 7, 15, and 18 have been canceled. Claims 21-32 have been added.

3. Claims 2, 4, 6, and 8-11 now depend from newly added claim 21. Claims 16 and 17 now depend from newly added claim 23. Claims 19 and 20 now depend newly added claim 26.

4. Claim 10 now specifies wherein the compressive stress in the second insulating layer is adjusted by controlling at least one film forming condition selected from the group consisting of film forming temperature, type of gaseous reaction mixture, and flow rate of the gaseous reaction mixture.

5. Claim 14 now specifies wherein the compressive stress in the second insulating layer is adjusted by controlling at least one film forming condition selected from the group consisting of frequency of plasma generating power, bias power applied to the substrate, film forming temperature, type of gaseous reactant, and flow rate of the gaseous reactant.

6. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

7. Claims 2-4, 8-9, 11-14, 16, 17, and 19-32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Itoh et al. in view of Maeda '546, Maeda '499, and Harriot.

Itoh, as cited by applicant, discloses in Figures 5(a) through 5(e): a semiconductor device and a method of manufacturing the semiconductor device with a metal wiring layer made of aluminum (31) formed on the substrate; a tensile stress insulation layer (411) is formed on the first metal wiring layer; a compressive stress insulation layer (412) is formed on top of the tensile stress insulation layer {column 4, lines 31-49}. Itoh also shows that a second metal wiring layer may be placed on top of the compression stressed insulation layer followed by a subsequent deposition of tensile and compression stressed insulation layers {column 6, lines 15-21}. Thus, the compressive and tensile insulation films are formed alternatively on top of each other. The stressed insulation films could be made of PECVD (plasma enhanced chemically vapor deposited) PSG (phosphor silicated glass), BPSG (boron phosphor silicated glass), or SiO_2 {column 5, lines 10-14}. Itoh also shows, in the abstract, that an insulator layer produced by PECVD is made compressive when a certain frequency of plasma generating power is reached.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to repeat the consecutive steps of forming the irradiated tensile insulation layer and forming the compressive insulation layer as many times as desired after formation of the metal wiring layer since this would require duplication of essential working steps and mere duplication of the essential working steps of a process involves only routine skill in the art.

Itoh fails to show forming an insulating film by heating and reacting a gas mixture including organic silane and oxygen containing gas or wherein the tensile stress insulation film is subjected to plasma irradiation after it is disposed on the substrate or wherein the stress (σ_t) in the overall stress-adjusted insulating film is adjusted according to:

$$\sigma_T = \sum_{i=1}^{n} (t_i \times \sigma_i)$$

where the overall (tensile or compressive) stress of the laminate is less than a maximum value, δ_T, where $\delta_T = 3 \times 10^5$ dyne/cm.

Maeda '546 (herein referred to as Maeda 546) shows a PSG, BPSG or SiO_2 film is formed as a chemically vapor deposited insulating film when reacting gases containing organic silane (containing alkoxy compound of silicon, siloxane, alkylsilane, and the like) and/or ozone (O_3) are mixed at a temperature range between 350°C and 450°C {column 2, lines 59-67}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the insulation material of Itoh using the reactant gases found in Maeda 546 because the reactant gases of Maeda 546 would have allowed for an SiO_2, PSG or BPSG layer to be formed on top of a semiconductor substrate.

Maeda '499 (herein referred to as Maeda 499) shows the results of an observation of two insulating film samples made of the same material wherein one sample was irradiated with plasma the other was not and the material properties were observed over a period of time. The sample

that was irradiated with plasma was determined to have a tensile stress. The other sample, which was not irradiated with plasma, initially had a tensile stress but grew to develop compressive stresses over time. Thus, by irradiating the insulating layer with plasma, a reduction in the change in the state of stress of that insulating layer was achieved {column 7, lines 30-46}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to irradiate the tensile insulating film in the invention of Itoh in view of Maeda 546 as in Maeda 499 because plasma irradiation would have reduced the time dependant change in the state of stress in the lamina and thus increased the reliability, over time, of the laminate and thus the device.

Harriot shows in the abstract that a laminated insulating film made of individual laminae stressed either in tension or compression can be made to exhibit a stress of -50MPa to +50MPa. Harriot also shows that the thicknesses of the individual insulating layers in the laminate contributes to the overall stress in the laminate {column 3, lines 11-13, 25-30}.

It would have been obvious that, since the second insulating layer of Itoh in view of its modifiers is always a compressively formed insulating layer and is always formed after the tensile insulating layer, it would always be the uppermost insulating layer of the device. It also would have been obvious to one of ordinary skill in the art at the time the invention was made to form the compressive insulation laminae of Itoh in view of its modifiers within a less than a specified maximum, as suggested by Harriot, in order to avoid problems associated with laminate delamination and to ensure a reliable device.

8. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Itoh in view of Maeda 546, Maeda 499, and Harriot as applied to claim 21 above, and further in view of Bacchetta et al..

Itoh in view of its modifiers substantially discloses the invention as claimed but fails to disclose wherein the gas mixture contains a gaseous impurity.

Bacchetta shows doped SiO_2 with boron yields BSG (boro silicate glass), and doping SiO_2 with phosphorous yields PSG (phospho silicate glass) {column 4, lines 24-30}. Bacchetta also shows that doped (with B or P or both) SiO_2 is commonly obtained directly upon CVD deposition of the layer {column 4, lines 54-56}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to include impurity atoms such as B or P or both in the manner of Bacchetta into the SiO_2 found the in the insulating layer of Itoh and Maeda 546, Maeda 499, and Harriot to form the PSG and BPSG insulating layers because it is well known in the art to do so.

9. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Itoh in view of Maeda 546, Maeda 499, and Harriot as applied to claim 21 above, and further in view of Morozumi.

Itoh in view of its modifiers substantially discloses the invention as claimed but fails to disclose wherein the film forming condition tool for adjusting the stress characteristics of respective insulating films is at least one selected from the group consisting of a film forming temperature, type of gas, and a flow rate of gas.

Morozumi discloses, in an analogous art relating to a method of manufacture of a dielectric layer, forming two dielectric layers using nearly the same vapor phase deposition process. One of the dielectric layers has a compression stress, the other has a tensile stress. The dielectric layer in tension was processed in an inert carrier gas - the inert gas caused the second insulating layer to inherit a state of tension.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the tension stressed insulator layer of Itoh and Maeda 546, Maeda 499, and Harriot in the manner of Morozumi by adding an inert gas into the mixture because doing so would have been an obvious process optimization and use of available apparatus.

Response to Arguments

10. Applicant's arguments filed 3/29/99 have been fully considered but they are not persuasive.

With respect to applicants arguments concerning the Maeda 499 reference: the Maeda 499 reference is relevant to a plasma treatment for adjusting stress in a single insulating film and in the context of the formation of a multi-layered insulating film with alternating layers of tensile and compressive insulating films by forming a tensile film prior to a compressive film and essentially repeating these two steps because a single non-irradiated insulating layer would have different stress characteristics than an irradiated insulating layer. Therefore, a laminate made up of non-irradiated tensile insulation layers alternately disposed adjacent to compressively stressed insulation layers would have different stress characteristics than a laminate made up of irradiated

tensile insulation layers alternately disposed adjacent to compressively stressed insulation layers. Since the plasma treatment affects an individual lamina of a laminate, and formation of that lamina is repeated throughout the laminate, the plasma treatment affects the stress characteristics of the laminate, and is thus extremely relevant to multi-layered films with compressive stress alternately disposed adjacent to layers of tensile stress.

At the present the newly amended claims state that the topmost layer of the multi-layer insulating film provides an overall stress for the film, thus the invention of Itoh in view of Maeda 546 Maeda 499 and Harriot shows that the top most layer of the laminate, as with all layers in the laminate, help to provide an overall stress in the laminate. Therefore, it would be necessary for the top most insulation layer of the insulating film to provide an overall stress for the multi-layer film since the overall stress of the multi-layer film would be different if that film were not present or were a different thickness. Harriot shows that the thickness of individual insulative laminae affects the overall stress characteristics of the laminate which comprises them. Therefore, Harriot recognizes that the overall stress of a laminate can be treated as being a function of the thicknesses of any of the laminae that comprise the laminate.

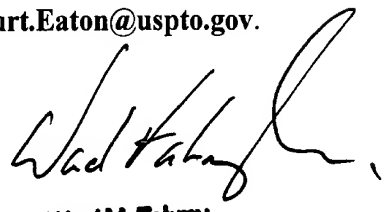
Conclusion

11. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

12. Paper related to this application may be submitted directly to Art Unit 2823 by facsimile transmission. Papers should be faxed to Art Unit 2823 via the Art Unit 2823 Fax Center located in the Crystal Plaza 4, room 4C23. The faxing of such papers must conform with the notice published in the Official Gazette, 1096 OG 30 (15 November 1989). The Art Unit 2823 Fax Center number is **(703) 308-7722 or -7724**. The Art Unit 2823 Fax Center is to be used only for papers related to Art Unit 2823 applications.

Any inquiry concerning this communication or earlier communication from the examiner should be directed to **Kurt Eaton** at **(703) 305-0383** and between the hours of 8:00 AM to 4:00 PM (Eastern Standard Time) Monday through Friday or by E-mail via **Kurt.Eaton@uspto.gov**.



Wael M. Fahmy
Primary Examiner

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